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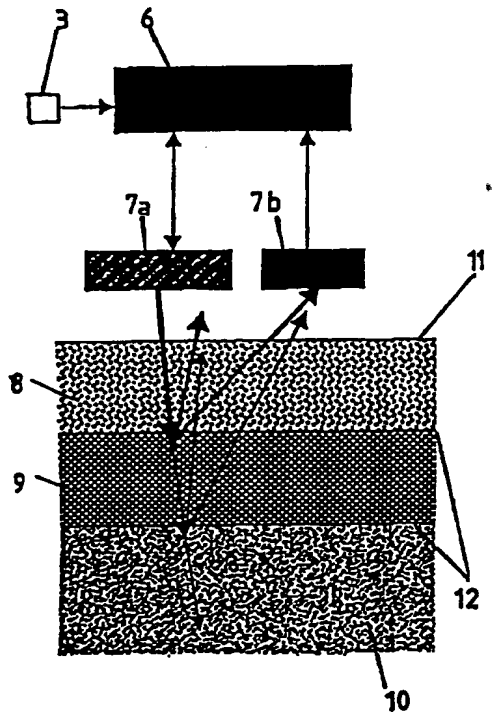
(54) Title: A METHOD OF DETECTING DEFECTS IN TRACK SUBGRADE AND AN APPARATUS FOR CARRYING OUT THE METHOD

(57) Abstract

Defects in track subgrade, particularly in a rail bed and railway track substructure body are detected by the radar control of subgrade, by continuously recording the permitivity of subgrade materials, while radar beams are transmitted into subgrade at least in two directions and reflected beams are received at least in two points after these beams in track subgrade have travelled different distances. The apparatus for detecting the defects contains the radar antenna system (7), carried by a railway track recording car, including the transmitting and detecting radar antennas (7a, 7b) and another detecting radar antenna (7b) for the reception of reflected signals travelling in different inclined trajectory than the reflected signals returning to the first radar antenna (7a). Radar antennas (7a, 7b) are connected with a radar control and recording unit (6) for recording a time lag between both of the reflected signals and for detecting anomalies in a rail bed and railway track substructure body.



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A method of detecting defects in track subgrade and an apparatus for carrying out the method

Technical Field

The invention concerns a method of detecting defects in track substructure, particularly in railway track substructure, including continuous light control and/or contact control of railway track superstructure as well as continuous radar control of the rail body of railway track substructure. The invention also concerns an apparatus for carrying out this method, containing a mobile carrier of the recording system, equipped with a reader of a distance travelled by a carrier on track, with a device for recording parameters of railway track travel and with a radar apparatus for control of the condition of railway track subgrade.

Background of the invention

The following are known so far: railway track superstructure recording car, containing railway track pulse reader which monitors a distance travelled and provides requested sampling frequency of individual recording apparatuses, and recording undercarriage carrying electromechanical position sensor for recording geometric parameters of railway track superstructure, i.e. superelevation and direction of stretches of rails, railway track gauge and rail warping, the output of which is connected to input of the recording and control unit for recording geometric parameters of a rail.

The purpose of the invention is to sort out the method and the apparatus of detecting defects of not only railway track superstructure, but also substructure, as numerous defects of railway track superstructure are caused by railway track substructure defects. The invention should also be applicable to other than railway track structures.

Summary of the Invention

This task has been resolved by a method of detecting defects in track subgrade, particularly in railway track substructure body, according to the invention serving for the

radar control of subgrade; the essence of the invention lies in the fact that the radar control of track subgrade includes continuous recording of subgrade, effected by transmitting radar beams into subgrade at least in two directions and by receiving reflected beams at least in two points after these beams in subgrade have travelled distances of varying lengths.

A preferred embodiment of the method according to the invention lies in the fact that the radar control of track subgrade is effected simultaneously and in synchronization with the light and/or contact control of track travel area, particularly railway track superstructure.

The invention concerns also an apparatus the essence of which lies in the fact that the radar apparatus for control of the condition of subgrade contains a system of radar antennas with at least one radar antenna. This system is connected to the second output of the radar control and recording unit, the first input of which is connected to by one of the outputs of interconnecting link. This link's input is connected to by a reader of longitudinal position of a mobile carrier of a recording system on track, while its another input is connected to the recording and control unit for recording geometric and physical parameters of track travel area.

A preferred embodiment of the apparatus in accordance with this invention lies in the fact that a system of radar antennas contains a transmitting radar antenna with axis oriented to subgrade and connected with the radar control and recording unit output, and at least one detecting radar antenna, connected with another input of the radar control and recording unit and located in adjusted space-gap next to a transmitting radar antenna for receiving a component of radar signals reflected from material boundaries in track subgrade.

In a particular advantageous embodiment of the apparatus according to the invention, a system of radar antennas and the radar control and recording unit are carried by a railway track recording car which is equipped with railway track pulse reader for recording longitudinal position of the arrangement on track and with electromechanical position detector for recording geometric and physical parameters of track surface

formed by railway track superstructure. Railway track pulse reader is connected via interconnecting link with the recording and control unit for recording geometric parameters of a rail, and interconnecting link is further connected with the radar control and recording unit input.

The advantage of a solution according to the invention is particularly the fact that in interpreting the results of radar detections it is possible immediately to correlate the results with standard results gained by the track recording car. It means that defects of geometric parameters of a rail can be adjoined to also by a reason for defect, usually consisting in disturbation of a certain part of sleeper subgrade and railway track substructure body, caused for example by subsidence process or by contamination of certain areas of ballast and subgrade layers. In addition, location of such defect, given by longitudinal and depth data, can also be determined. This leads to repairs of defects optimizing, as defective (disturbed) points in railway track substructure by applying the method and the apparatus according to the invention can be registered earlier than they show up in the quality of railway track superstructure.

The method and the apparatus according to the invention allow simultaneous recording of railway track superstructure and substructure parameters. Both types of recording are exactly bound to each other, therefore the relation found between defects of geometric parameters of a rail and a rail body and railway track substructure can be determined with high accuracy. The monitoring of rail substructure – from the time viewpoint – is thus determined exactly. The application of radar recording by the apparatus according to the invention can increase operational speed of radar motion from current 10 – 15 km/h to as much as 70 – 140 km/h, depending on a type of track recording car.

Brief description of the drawings

The invention will be explained in detail with the application of embodiment examples made on drawings where they illustrate the following:

Fig. 1: Block diagram of the apparatus serving for executing the method applied to the detection of railway track superstructure and substructure defects,

Fig. 2: Section through the first example of embodiment of antennas and their connection to the control and recording unit in the apparatus from Fig. 1, and

Fig. 3: Section through the second example of embodiment of antennas and their connection to the control and recording unit in the apparatus from Fig. 1.

Examples

The apparatus for detecting defects in track superstructure and substructure is in the illustrated particular embodiment example arranged for detecting defects in railway track superstructure and substructure, represented in railway track superstructure by defects in geometric parameters of a rail, and in railway track substructure by deformations of a rail bed and construction layers of railway track superstructure body that are or will be in future the reason for changes of geometric parameters of a rail.

The apparatus according to the invention includes the track recording car 1, the undercarriage of which is fitted with railway track pulse reader 2, by which the distance travelled by the track recording car 1 is recorded, and its immediate position on track determined. The railway track pulse reader 2 output is connected via interconnecting link 3 and its first output with one input of the recording and control unit 4 for detecting and recording geometric parameters of a rail. The second input of the recording and control unit 4 is connected to by electromechanical position detector 5, fixed on the recording undercarriage of the track recording car 1 and recording geometric parameters of railway track superstructure 11, i.e. superelevation and direction of stretches of rails, railway track gauge and rail warping.

As mentioned earlier, railway track pulse reader 2 in this example of embodiment according to the invention is connected with the recording and control unit 4 for detecting geometric parameters of a rail via interconnecting link 3, the second output of which is connected to the first output of the radar control and recording unit 6. The radar control and recording unit 6 has its outputs and inputs connected to the radar antenna system 7 for detecting the condition of railway track substructure, particularly

the subsidence of rail bed layers and construction layers of railway track substructure body.

The radar antenna system 7 in the first embodiment example, illustrated on Fig. 2, is formed by the first radar detecting antenna 7a which transmits a radar signal into sleeper subgrade consisting of top ballast layer 8 containing unillustrated sleepers, subgrade construction layer 9, and compacted soil base 10. The first radar detecting antenna 7a is oriented in standard direction to railway track superstructure surface 11 and connected to the first input of the radar control and recording unit 6. The second radar detecting antenna 7b, connected with the second input of the radar control and recording unit 6, is located in exactly determined lateral space gap from the first radar detecting antenna 7a and in the same height above railway track superstructure surface 11.

The first radar detecting antenna 7a transmits a radar signal into sleeper subgrade and in this first arrangement example also intercepts reflected standard signal which is transferred to the radar control and recording unit 6. These registered values cannot serve for an explicit assessment of the railway track substructure condition as such values would have to be corrected by values of relative permitivity of materials contained in sleeper subgrade, it means top ballast layer 8, construction layer 9 and soil forming soil base 10.

In order to find out in the easiest manner the values of relative permitivity of materials forming railway track substructure, the second radar detecting antenna 7b is applied. This antenna intercepts inclined components of reflected radar beams that are transmitted from the first radar detecting antenna 7a in direction deflected at angle of approx. 30° from longitudinal central axis of the first radar detecting antenna 7a which is a transmitting antenna, so the beams travel in trajectory inclined at angle of approx. 60° to longitudinal axis of a rail to a beam reflection point from which the beams are reflected, and return in reflected direction at angle of 30° – 45° contained with longitudinal axis of a rail to the second radar detecting antenna 7b. A radar signal arrives to this antenna with time lag depending on the one hand on the extension of its trajectory and on the other hand on relative permitivity of railway track substructure materials. Radar beams are reflected on material boundaries 12 between top ballast layer 8,

construction layer 9 and soil base 10, while rather a sudden change of distance of at least some of the material boundaries from the radar antenna system 7 indicates subsidence of subgrade layers and thus a local defect of railway track substructure. These intercepted reflected signals are transferred to the radar control and recording unit 6, where reflections intercepted by the first radar detecting antenna 7a are compared with reflections intercepted by the second radar detecting antenna 7b, and the results of comparison with the use of inserted memory device can serve for the determination of values of relative permitivity of railway track substructure materials.

The second embodiment example of the radar antenna system 7 of the apparatus according to the invention, illustrated on Fig. 3, includes the separate transmitting radar antenna 7d, connected to the radar control and recording unit 6 output, the second radar detecting antenna 7b and the third separate radar detecting antenna 7c. All three antennas of the radar antenna system 7 are located in plane which is in parallel with axis of a rail, in positions being in determined space gaps from each other, the third radar detecting antenna 7c being located in bigger distance from the transmitting radar antenna 7d than the second radar detecting antenna 7b, and this difference in distances must be sufficient enough so that a time lag between arrival of radar signals from individual material boundaries to the second radar detecting antenna 7b and to the third radar detecting antenna 7c could be detected reliably. Both of the radar detecting antennas 7b and 7c are connected to two inputs of the radar control and recording unit 6 in which with the use of its programme equipment the values of relative permitivity of a rail bed and railway track substructure body can be determined.

CLAIMS

1. A method of detecting defects in track subgrade, particularly of a rail bed and railway track substructure body, including light control and/or contact control of track travel area as well as continuous radar control of track subgrade, characterized in that the radar control of track subgrade includes continuous recording of permitivity of subgrade materials, effected by transmitting radar beams into subgrade at least in two directions and by receiving reflected beams at least in two points after these beams after reflection in track subgrade have travelled distances of varying lengths.

2. The method according to claim 1, characterized in that the radar control of track substructure is effected simultaneously and in synchronization with the light and/or contact control of track travel area, particularly railway track superstructure.

3. An apparatus for carrying out the method according to claims 1 and 2, including a mobile carrier of the recording system, equipped with a reader of a distance travelled by a carrier on track, with a device for recording parameters of railway track travel and with a radar apparatus for control of the track subgrade condition, characterized in that the radar apparatus for control of the subgrade condition contains the radar antenna system (7) with at least one radar antenna (7a, 7d), this system being connected to the second output of the radar control and recording unit (6), the first input of which is connected to one of the outputs of interconnecting link (3), and this link's input is connected to a reader (2) of longitudinal position of a mobile carrier of a recording system on track, while its another output is connected to the recording and control unit (4) for recording geometric and physical parameters of track travel area.

4. The apparatus according to claim 3, characterized in that the radar antenna system (7) contains a transmitting radar antenna (7a, 7d) with axis oriented to subgrade and connected with the radar control and recording unit (6) output, and at least one detecting radar antenna (7b, 7c), connected with another input of the radar control and recording unit (6) and located in adjusted time-gap next to a transmitting radar antenna (7a, 7d) for receiving a component of radar signals reflected from material boundaries in track subgrade.

5. The apparatus according to claims 3 and 4, characterized in that the radar antenna system (7) and the radar control and recording unit (6) are carried by a railway track recording car (1) which is equipped with railway track pulse reader (2) for recording longitudinal position of the arrangement on track and with electromechanical position detector (5) for recording geometric and physical parameters of track surface formed by railway track superstructure, while railway track pulse reader (2) is connected via interconnecting link (3) with the recording and control unit (4) for recording geometric parameters of a rail, and interconnecting link (3) is further connected with the radar control and recording unit (6) input.

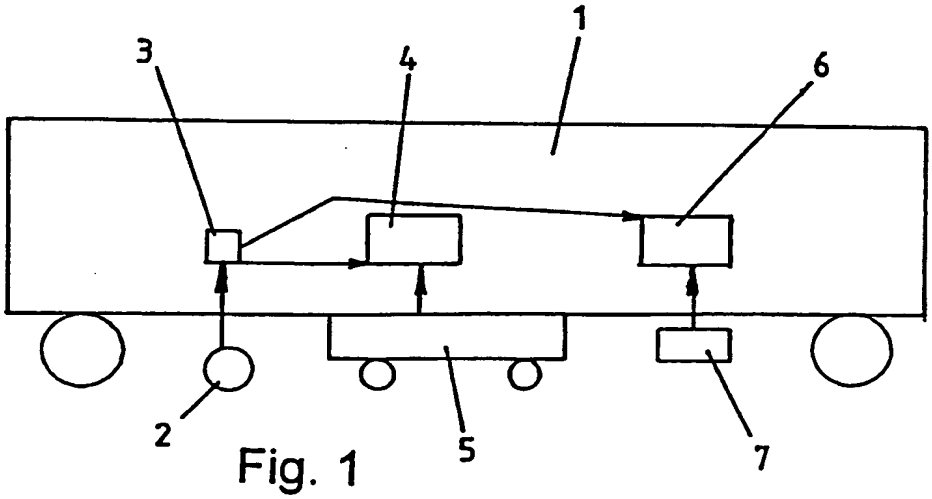

Fig. 1

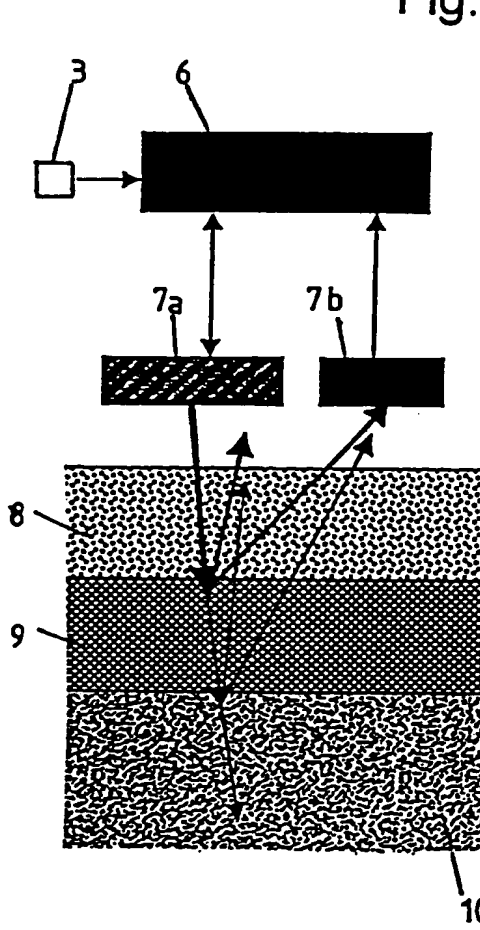

Fig. 2

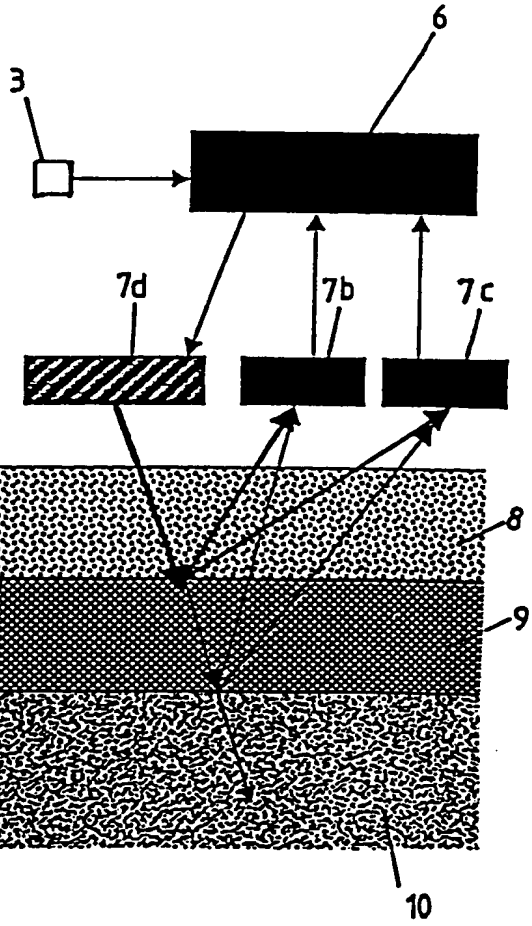

Fig. 3

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B61K9/08 E01B35/00 G01S13/88

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IPC 7 B61K B61D B61L E01B G01S

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US 3 924 461 A (STOVER HARRIS A) 9 December 1975 (1975-12-09) column 2, line 4 -column 4, line 16 column 6, line 64 -column 7, line 19; figures 1-14 ---	1,3
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